Thin Film Technologies Project FY96 Summary

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The Thin Film Technologies Project includes in-house R&D in CIS, CdTe, and amorphous silicon as well as subcontracted R&D within the Thin Film PV Partnership. Research is conducted by research teams within each organization and by cooperative National Research Teams in amorphous silicon, cadmium telluride, CIS, and Thin Film ES&H.

Some of the highlights for the fiscal year include:

In CIS:

- NREL researchers added substantially to their world record cell efficiency (see Figure 1) by reaching 17.7% efficiency on a CIGS cell.

In CdTe:

- Solar Cells Inc. fabricated a 9.1% efficient very large area CdTe module (see Table 1), meeting several of our Annual Operating Plan milestones for the CdTe technology. This is the most efficient thin film module of its size.
- Solar Cells Inc. CdTe systems (1-10 MW) demonstrated 1-3 year outdoor stability at various locations (e.g., NREL, PVUSA, Ohio Edison).
- Golden Photon fabricated the highest efficiency CdTe cells made on low-cost, soda lime glass (14.8% efficient). They also produced a near-30 W CdTe module of about 3400 cm^2 area.
- Golden Photon identified stability as a critical issue for their approach to manufacturing CdTe modules.

In amorphous silicon:

- United Solar made a significant advance in the world record efficiency for a-Si cells, reaching a NREL-measured stabilized efficiency (total area basis) of 11.8%. The previous best was about 10.9%. This is the first significant advance in a-Si cell efficiency in more than 5 years.

The thin film technologies made progress toward commercial readiness. In amorphous silicon, both Technology Partners (Solarex and United Solar) began construction of amorphous silicon production plants of sizes larger than had previously existed (USSC Troy, MI, 5 MW plant; Solarex, 10 MW Virginia plant). The two CdTe Technology Partners, GPI and SCI, delivered about 200 kW of product from pilot lines, including 25 kW each to a Navy-sponsored experiment at Edwards Air Force Base in California. Several of the CIS companies are experimenting with sub-MW pilot lines. Despite this progress, no thin film technology has yet reached substantial commercial presence in PV measured by annual worldwide production. Further technological and transitional scale-up to manufacturing issues must be addressed on an ongoing basis.

Figure 1. The Best Polycrystalline Thin Film Laboratory Cells (1996)

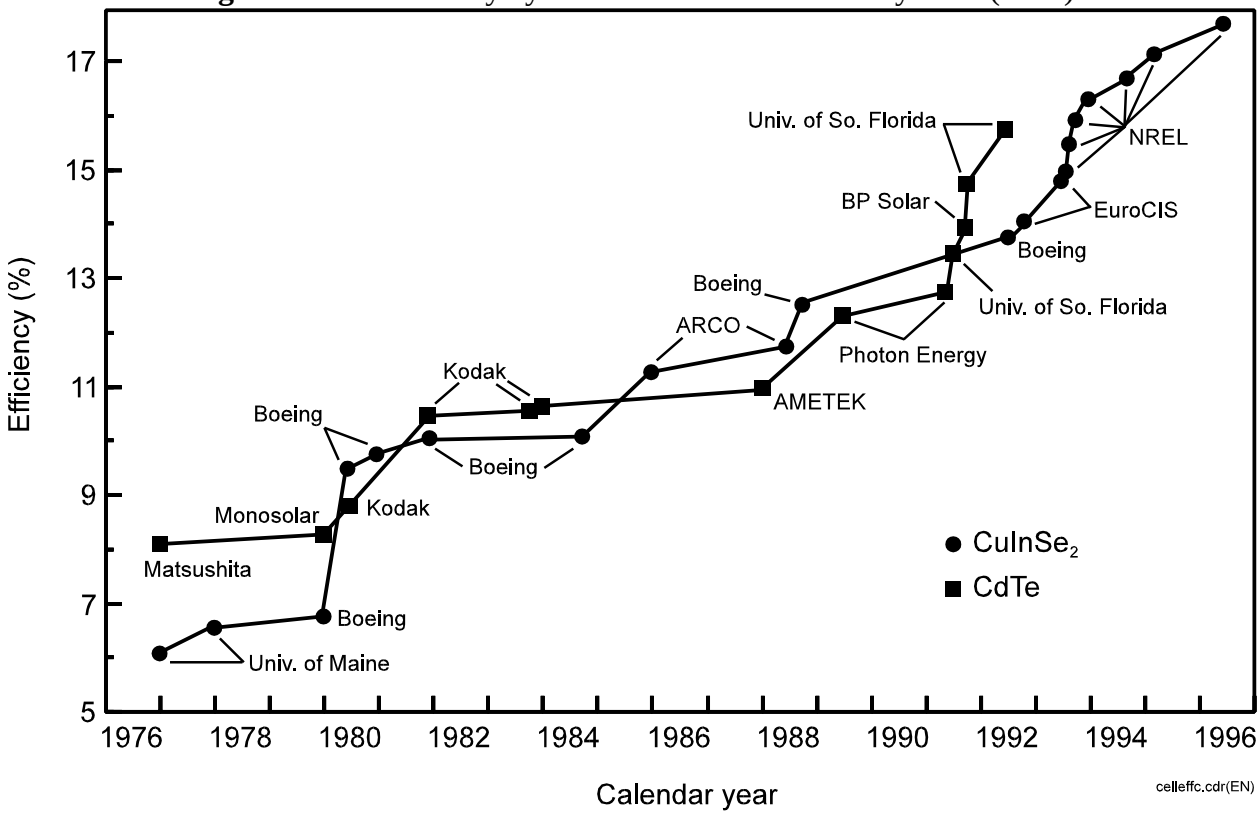

Table 1. The Best Thin Film Modules (1996)

Material	Size (cm^2)	Efficiency (%)	Power (Watts)	Company & comments
CdTe	6728	9.1	61.3	Solar Cells Inc.
$CuInSe_2$ (CIS)	3859	10.2	39.3	Siemens Solar Industries
Amorphous silicon	3906	7.8	30.6	Energy Conversion Devices
CdTe	3350	8.7	29.3	Golden Photon Inc.
Amorphous Silicon	3432	7.8	26.9	United Solar Systems (USSC)
Amorphous Silicon	1200	8.9	10.7	Fuji (Japan)
$CuInSe_2$ (CIS)	938	11.1	10.4	ARCO Solar (now Siemens Solar Industries)
CdTe	1200	8.7 (reported)	10.0	Matsushita (Japan)
Amorphous Silicon	902	10.2	9.2	USSC

Note: Efficiencies verified independently at NREL unless noted as 'reported'; for a-Si they are after 600 hours light-soaking.